THE DISTRIBUTION OF WATERFOWL BANDED OR RETURNED IN BRITISH COLUMBIA, 1951 - 1985

R. McKelvey
G.E.J. Smith

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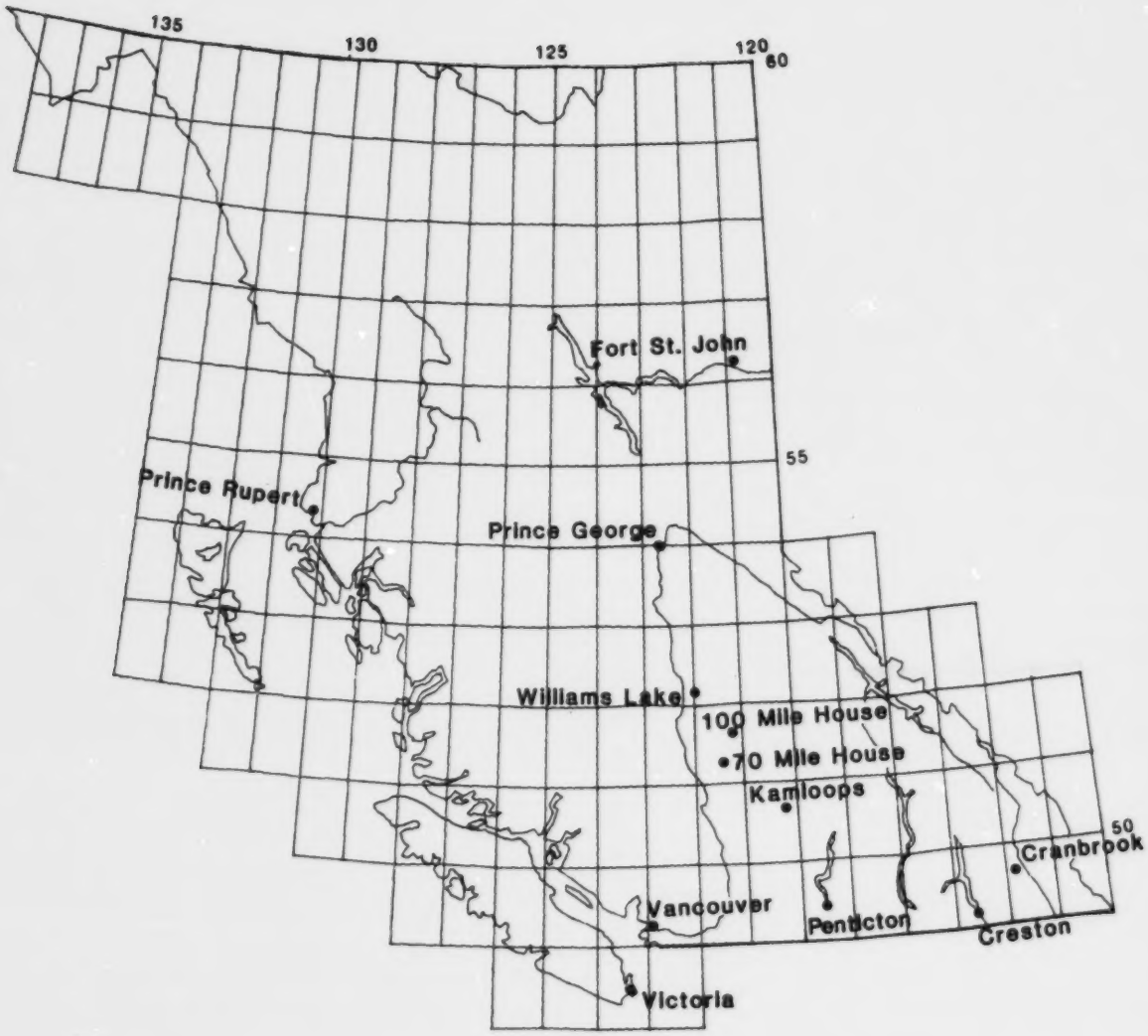
Errata to The Distribution of Waterfowl Banded and Returned in British Columbia, 1951 - 1985.

Band return data for Figure 14 did not get printed. The numbers of returns and their latitudes and longitudes are:

latitude	longitude	number of returns
49	124	4
49	123	4
48	123	3
47	123	1
46	124	1
45	124	1

In addition, two people who assisted with final production went unacknowledged. K. Moore produced the drafted figures (all others were computer generated) and P. Whitehead proofed the manuscript and expedited printing.



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ABSTRACT

The distribution patterns of 26 species of ducks banded in British Columbia between 1951 and 1984, and of Canada Geese banded between 1951 and 1985 were analysed. Two major reference areas were delineated: the interior, where birds were banded on the breeding grounds; and the coast, where birds were banded on a wintering area, primarily during hunting season. No significant numbers of ducks have been banded in the interior since the early 1960's, and on the coast since the late 1970's.

Banding returns from the interior indicated a moderate local harvest occurred for Mallard, Blue-winged Teal, Shoveler, Redhead, Lesser Scaup and Bufflehead; a heavy local harvest for Barrow's Goldeneye; and a light local harvest for Wigeon, Green-winged Teal, Pintail and Canvasback. Banding returns from the coast indicate that Mallard, Wigeon and Pintail found on the coast were primarily wintering birds, while Green-winged Teal tended to be migrants. Most returns outside of British Columbia were from the Pacific Flyway with Washington, Oregon and California being the main sources of hunting pressure.

Ducks returned in British Columbia but banded elsewhere came from a large part of the Pacific northwest. Alaska and Alberta were important sources of Mallard, Wigeon, Shoveler, Pintail and Bufflehead while Alaska was a further source of Green-winged Teal, Canvasback, and Lesser Scaup.

Large Canada Geese nesting in British Columbia supplied good local harvest, as well as supplementing the harvest in Alberta, Washington and parts of Oregon and California. Small Canada Geese passing through the interior of British Columbia nested in Alaska and wintered primarily in the Columbia River basin of eastern Washington.

The need for more waterfowl banding was discussed. It was recommended

that monitoring programs be initiated, to determine the current hunting pressure on local populations, to provide information for improving waterfowl management in the Pacific Flyway and, with adequate sample size, to measure survival and mortality of the more abundant species such as the mallard.

RÉSUMÉ

Les modèles de distribution de 25 espèces de canards baqués en Colombie-Britannique entre 1951 et 1984, et de bernaches du Canada baquées entre 1951 et 1985 ont été analysés. Deux grandes régions de référence ont été délimitées: l'intérieur, où les oiseaux ont été baqués dans les aires de nidification; et la côte, où les oiseaux ont été baqués dans une aire d'hivernage, surtout durant la saison de chasse. Aucun nombre important de canards n'a été baqué dans l'intérieur depuis le début des années 60, et sur la côte, la fin des années 70.

Les retours de baques à l'intérieur des terres montrent que les canards colverts, les sarcelles à ailes bleues, les canards souchets, les morillons à tête rouge, les petits morillons et les petits garrots font l'object d'une chasse locale modérée; que les garrots de Barrow font l'object d'une forte chasse locale; et que les canards siffleurs, les sarcelles à ailes vertes, les canards pilets et les morillons à dos blanc sont l'objet d'une faible chasse locale. Les retours de baques sur la côte indiquent que les canards colverts, les canards siffleurs et les canards pilets sont surtout des oiseaux hivernants, tandis que les sarcelles à ailes vertes ont tendance à être des migrants. Presque tous les retours effectués à l'extérieur de la Colombie-Britannique venaient de la voie

migratoire du Pacifique, les états de Washington, de l'Orégon et de la Californie étant les principales source de pressions exercées par la chasse.

Les canards de retour en Colombie-Britannique mais bagués ailleurs venaient en majeure partie du Pacifique nord-ouest. L'Alaska et l'Alberta étaient une source importance de canards colverts, de canards siffleurs, de canards souchets, de canards pilets et de petits garrots, et l'Alaska était en outre une source de sarcelles à ailes vertes, de morillons à dos blanc et de petits morillons.

Les grandes berraches du Canada qui nichent en Colombie-Britannique ont fait l'objet d'une bonne chasse locale, ainsi qu'en Alberta, dans l'État de Washington et dans certaines parties de l'Orégon et de la Californie. Les petites bernaches du Canada qui traversent l'intérieur de la Colombie-Britannique nichent en Alaska et hivernent surtout dans le bassin du fleuve Columbia, dans l'est de l'État de Washington.

La nécessité de baguer un plus grand nombre d'oiseaux aquatiques a fait l'objet de discussions. On a recommendé de mettre en oeuvre des programmes de surveillance afin de déterminer les pressions actuelles exercées par la chasse sur les populations locales, de fournir des renseignements de façon à améliorer la gestion de la sauvagine dans la voie migratoire du Pacifique et, à l'aide d'échantillons représentatifs, d'évaluer les taux de survie et de mortalité chez les espèces les plus nombreuses, comme le canard colvert.

Page

Abstract ii

Resume iii

List of Tables vi

List of Figures viii

Introduction 1

Methods 3

Results & Discussion 6

General band recovery synopsis 6

Recoveries by species 13

Mallard 13
Gadwall 26
Wigeon 32
Green-winged Teal 41
Blue-winged Teal 46
Shoveler 51
Pintail 56
Wood Duck 64
Redhead 70
Canvasback 74
Lesser Scaup 79
Barrow's Goldeneye 85
Bufflehead 89
Canada Goose 95

Conclusions 107

Literature Cited 110

Acknowledgements 111

Appendices

I Species and numbers of waterfowl banded in British Columbia between 1951 and 1984. 112

II Minor species of waterfowl banded in British Columbia between 1951 and 1984. 114

LIST OF TABLES

Table 1. Major banding locations, as defined by degree block of banding, for waterfowl banded in British Columbia between 1951 and 1984. 4

Table 2. Geographic area in which Canada Goose banding has occurred in British Columbia, and the number of returns in each area, from 1951 to 1985. 7

Table 3. Total numbers of the major species of ducks banded in British Columbia from 1951 to 1984. 10

Table 4. Number of recoveries of the major species of ducks banded in British Columbia from 1951 to 1984, by banding location. 11

Table 5. Band return rates for the major species of ducks banded in the interior and on the coast of British Columbia between 1951 and 1984. 12

Table 6. Summary of relative distribution of Mallard recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. 14

Table 7. Summary of relative distribution of Mallard recoveries, by age and sex, for birds banded on the coast of British Columbia between 1951 and 1984. 20

Table 8. Summary of relative distribution of Gadwall recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. 27

Table 9. Summary of relative distribution of Gadwall recoveries, by age and sex, for birds banded on the coast of British Columbia between 1951 and 1984. 27

Table 10. Summary of relative distribution of Wigeon recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. 33

Table 11. Summary of relative distribution of Wigeon recoveries, by age and sex, for birds banded on the coast of British Columbia between 1951 and 1984. 33

Table 12. Summary of relative distribution of Green-winged Teal recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. 42

Table 13. Summary of relative distribution of Blue-winged Teal recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. 47

Table 14. Summary of relative distribution of Shoveler recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. _____ 52

Table 15. Summary of relative distribution of Pintail recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. _____ 57

Table 16. Summary of relative distribution of Pintail recoveries, by age and sex, for birds banded on the coast of British Columbia between 1951 and 1984. _____ 57

Table 17. Summary of relative distribution of Wood Duck recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. _____ 65

Table 18. Summary of relative distribution of Wood Duck recoveries, by age and sex, for birds banded on the coast of British Columbia between 1951 and 1984. _____ 65

Table 19. Summary of relative distribution of Redhead recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. _____ 71

Table 20. Summary of relative distribution of Canvasback recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. _____ 75

Table 21. Summary of relative distribution of Lesser Scaup recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. _____ 80

Table 22. Summary of relative distribution of Barrow's Goldeneye recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. _____ 86

Table 23. Summary of relative distribution of Bufflehead recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984. _____ 90

LIST OF FIGURES

Page

Frontice Piece Province of British Columbia.

Figure 1. Location of the banding areas delineated for duck banding in British Columbia. 5

Figure 2. Numbers of large Canada Geese returned by degree block of banding. 8

Figure 3. Numbers of small Canada Geese returned by degree block of banding. 9

Figure 4. The distribution of direct returns of Mallards banded in the interior of British Columbia between 1951 and 1984. 15

Figure 5. The distribution of indirect returns of Mallards banded in the interior of British Columbia between 1951 and 1984. 16

Figure 6. The distribution of direct returns of Mallards banded on the coast of British Columbia between 1951 and 1984. 17

Figure 7. The distribution of indirect returns of Mallards banded on the coast of British Columbia between 1951 and 1984. 18

Figure 8. The distribution of direct returns in British Columbia of Mallards banded in Alberta. 22

Figure 9. The distribution of direct returns in British Columbia of Mallards banded in Mackenzie District. 23

Figure 10. The distribution of direct returns in British Columbia of Mallards banded in Yukon. 24

Figure 11. The distribution of direct returns in British Columbia of Mallards banded in Alaska. 25

Figure 12. The distribution of direct returns of Gadwall banded in the interior of British Columbia between 1951 and 1984. 28

Figure 13. The distribution of indirect returns of Gadwall banded in the interior of British Columbia between 1951 and 1984. 29

Figure 14. The distribution of direct returns of Gadwall banded on the coast of British Columbia between 1951 and 1984. 30

Figure 15. The distribution of indirect returns of Gadwall banded on the coast of British Columbia between 1951 and 1984. 31

Figure 16. The distribution of direct returns of Wigeon banded in the interior of British Columbia between 1951 and 1984. 34

Figure 17. The distribution of indirect returns of Wigeon banded in the interior of British Columbia between 1951 and 1984. 35

Figure 18. The distribution of direct returns of Wigeon banded on the coast of British Columbia between 1951 and 1984. 36

Figure 19. The distribution of indirect returns of Wigeon banded on the coast of British Columbia between 1951 and 1984. 37

Figure 20. The distribution of direct returns in British Columbia of Wigeon banded in Alberta, Mackenzie District and Yukon. 39

Figure 21. The distribution of direct returns in British Columbia of Wigeon banded in Alaska. 40

Figure 22. The distribution of direct returns of Green-winged Teal banded in the interior of British Columbia between 1951 and 1984. 43

Figure 23. The distribution of indirect returns of Green-winged Teal banded in the interior of British Columbia between 1951 and 1984. 44

Figure 24. The distribution of direct returns in British Columbia of Green-winged Teal banded in Alberta, Yukon and Alaska. 45

Figure 25. The distribution of direct returns of Blue-winged Teal banded in the interior of British Columbia between 1951 and 1984. 48

Figure 26. The distribution of indirect returns of Blue-winged Teal banded in the interior of British Columbia between 1951 and 1984. 49

Figure 27. The distribution of direct returns in British Columbia of Blue-winged Teal banded in Alberta. 50

Figure 28. The distribution of direct returns of Shovelers banded in the interior of British Columbia between 1951 and 1984. 53

Figure 29. The distribution of indirect returns of Shovelers banded in the interior of British Columbia between 1951 and 1984. 54

Figure 30. The distribution of direct returns in British Columbia of Shovelers banded in Alberta and Alaska. 55

Figure 31. The distribution of direct returns of Pintail banded in the interior of British Columbia between 1951 and 1984. 58

Figure 32. The distribution of indirect returns of Pintail banded in the interior of British Columbia between 1951 and 1984. 59

Figure 33. The distribution of direct returns of Pintail banded on the coast of British Columbia between 1951 and 1984. 60

Figure 34. The distribution of indirect returns of Pintail banded on the coast of British Columbia between 1951 and 1984. 61

Figure 35. The distribution of direct returns in British Columbia of Pintail banded in Alaska. 62

Figure 36. The distribution of direct returns in British Columbia of Pintail banded in Mackenzie District, Yukon and Alberta. 63

Figure 37. The distribution of direct returns of Wood Duck banded in the interior of British Columbia between 1951 and 1984. 66

Figure 38. The distribution of indirect returns of Wood Duck banded in the interior of British Columbia between 1951 and 1984. 67

Figure 39. The distribution of direct returns of Wood Duck banded on the coast of British Columbia between 1951 and 1984. 68

Figure 40. The distribution of indirect returns of Wood Duck banded on the coast of British Columbia between 1951 and 1984. 69

Figure 41. The distribution of direct returns of Redhead banded in the interior of British Columbia between 1951 and 1984. 72

Figure 42. The distribution of indirect returns of Redhead banded in the interior of British Columbia between 1951 and 1984. 73

Figure 43. The distribution of direct returns of Canvasback banded in the interior of British Columbia between 1951 and 1984. 76

Figure 44. The distribution of indirect returns of Canvasback banded in the interior of British Columbia between 1951 and 1984. 77

Figure 45. The distribution of direct returns in British Columbia of Canvasback banded in Alberta and Alaska. 78

Figure 46. The distribution of direct returns of Lesser Scaup banded in the interior of British Columbia between 1951 and 1984. 81

Figure 47. The distribution of indirect returns of Lesser Scaup banded in the interior of British Columbia between 1951 and 1984. 82

Figure 48. The distribution of direct returns in British Columbia of Lesser Scaup banded in Alberta, Yukon and Alaska. 84

Figure 49. The distribution of direct returns of Barrow's Goldeneye banded in the interior of British Columbia between 1951 and 1984. 87

Figure 50. The distribution of indirect returns of Barrow's Goldeneye banded in the interior of British Columbia between 1951 and 1984. 88

Figure 51. The distribution of direct returns of Bufflehead banded in the interior of British Columbia between 1951 and 1984. 91

Figure 52. The distribution of indirect returns of Bufflehead banded in the interior of British Columbia between 1951 and 1984. 92

Figure 53. The distribution of direct returns in British Columbia of Bufflehead banded in Alberta. 93

Figure 54. The distribution of direct returns in British Columbia of Bufflehead banded in Alaska. 94

Figure 55. Recoveries of large Canada Geese banded near Vanderhoof between 1951 and 1985. 97

Figure 56. Recoveries of large Canada Geese banded in the Chilcotin between 1951 and 1985. 98

Figure 57. Recoveries of large Canada Geese banded near 100 Mile House between 1951 and 1985. 99

Figure 58. Recoveries of large Canada Geese banded near Kamloops between 1951 and 1985. 100

Figure 59. Recoveries of large Canada Geese banded in the Okanagan between 1951 and 1985. 101

Figure 60. Recoveries of large Canada Geese banded in the West Kootenays between 1951 and 1985. 102

Figure 61. Recoveries of large Canada Geese banded in the East Kootenays between 1951 and 1985. 103

Figure 62. Recoveries of large Canada Geese banded near Vancouver between 1951 and 1985. 104

Figure 63. Recoveries of large Canada Geese banded on northern Vancouver Island between 1951 and 1985. 105

Figure 64. Recoveries of small Canada Geese banded near Vanderhoof between 1951 and 1985. 106

INTRODUCTION

Waterfowl banding can provide information on a variety of topics of critical interest to wildilfe managers. The most obvious is the delineation of migratory paths taken between the breeding and wintering areas, and the locating of important stop-over or resting areas enroute. Recoveries of bands can also be used to determine the timing of movements, to estimate mortality and survival rates, and to determine differential vulnerability to harvest by species, age and sex. This information can then be used to set harvest regulations, and to evaluate and change those regulations as required to meet management objectives.

By and large the major migratory pathways of North American waterfowl are well known (see e.g. Bellrose (1976)). For some areas and for some species these pathways are understood in considerable detail, as are more technical factors such as survival rates, and the effects of age and sex on hunting survivability (see e.g. Anderson (1975) and Munro and Kimball (1982)). Knowledge at that level has come about from intensive long-term banding studies on the prairies, where the majority of the continents waterfowl reside during the breeding season (see North American Waterfowl Management Plan (1987)).

Banding information has been used to model population fluctuations of some species, most notably the Mallard. The aim of such simulation models has generally been to help managers better understand what factors are the most important determinants of population size, and how those can be manipulated, e.g. through hunting. The Mallard has been the focus of much of this work because it is one of the most abundant species and the one most sought after by hunters.

In the course of developing those models it has been found that more information is required from areas outside the prairies (Anderson (1975)). If

population biology of the Mallard is to be understood on a continental basis more banding information is required in parts of Ontario, British Columbia, northern Canada, and Alaska. Presumably such information will also be required for species other than the Mallard, as biologists are able to redirect their management efforts.

Waterfowl banding has a long history in British Columbia although it never has been very intensive. Other than the above cited reports neither has any detailed summary been produced. Knowing that there was a need from the continental perspective for more banding information from British Columbia, it seemed appropriate to review waterfowl banding in British Columbia before proposing to embark on new studies.

The purpose of this paper is to sumarize what is known about the continental distribution of waterfowl banded in British Columbia. The time interval covered is 1951 to 1984 for ducks, and 1951 to 1985 for geese. Banding data prior to 1951 were not used because they were few, quite localized, and probably not particularly relevant given the degree of range-wide habitat change that has occurred since.

Information is presented on the general results of waterfowl banding and more specific information follows by species. All species occurring regularly in British Columbia were considered. However, because certain species were banded infrequently distribution maps of band returns have been provided only for the major species: Mallard, Gadwall, Wigeon, Green-winged Teal, Blue-winged Teal, Shoveler, Wood Duck, Pintail, Redhead, Canvasback, Lesser Scaup, Barrow's Goldeneye, Bufflehead, and "large" and "small" Canada Geese. Return information in narrative form has been included for the minor species: Common Merganser, Red-breasted Merganser, Hooded Merganser, Cinnamon Teal, Greater Scaup, Ring-necked Duck, Oldsquaw, Harlequin Duck, White-winged Scoter, Surf Scoter, and Ruddy Duck. The distribution pattern of band recoveries of birds

banded elsewhere and returned in British Columbia is also included. Conclusions are then presented on what areas seem to be the most important sources of hunted birds, where the harvest is concentrated, and where more banding is required.

METHODS

Band return records for this report were obtained from the Bird Banding Office, Canadian Wildlife Service, Ottawa, and analysed and plotted using computer programs developed by the authors. Most waterfowl banding in British Columbia has occurred on the better quality breeding habitat, which is of limited quantity and very patchily distributed. In order to see if those areas might be supporting identifiable populations of ducks, recovery locations were plotted for each banding area, as shown in Table 1 and Figure 1.

The data were sorted to exclude birds other than normal wild caught birds, or experimental birds where the nature of the experiement (e.g. colour banding) was likely to have changed the probability of survival. Birds were also excluded that were not shot or found dead during the hunting season. Returns of birds in which the number of hunting seasons survived could not be calculated were treated as indirect returns (birds surviving one or more hunting season) for plotting recovery maps, and were excluded for calculations of return rates by age and sex. Recovery locations were plotted onto degree block maps of western North America by direct (birds killed in the first hunting season after banding) and indirect returns. For most species the number of returns was small and differential patterns of distribution between banding areas could not be determined. For all species therefore, data were combined and plotted for two major reference areas, the interior (areas 1-8: see Table 1), and the coast (area 9).

The origins of birds recovered in British Columbia from populations

Table 1. Major banding locations, as defined by degree block of banding, for ducks banded in British Columbia between 1951 and 1984.

Location	Degree Blocks Included
1) Fort St. John	56 x 120, 55 x 120, 56 x 121, 55 , 121
2) Williams Lake	53 x 122, 53 x 123, 52 x 122, 52 x 123, 514 x 1220 to 514 x 1235 incl. 520 x 1213 to 535 x 1213 incl.
3) 70 Mile House	510 x 1202, 510 x 1220 to 514 x 1220 incl.
4) Kamloops	50 x 120
5) Okanagan	49 x 118, 49 x 119, 50 x 118, 50 x 119
6) Creston	49 x 116
7) East Kootenays	49 x 114, 49 x 115, 500 to 505 x 115 to 1163 incl.
8) "The Rest"	Any other part of the province. Currently includes areas near Valemont and Prince George.
9) Coast	480 x 1213 to 500 x 1213 480 x 1260 to 500 1260 490 x 1213 to 490 x 1230, incl 480 x 1230

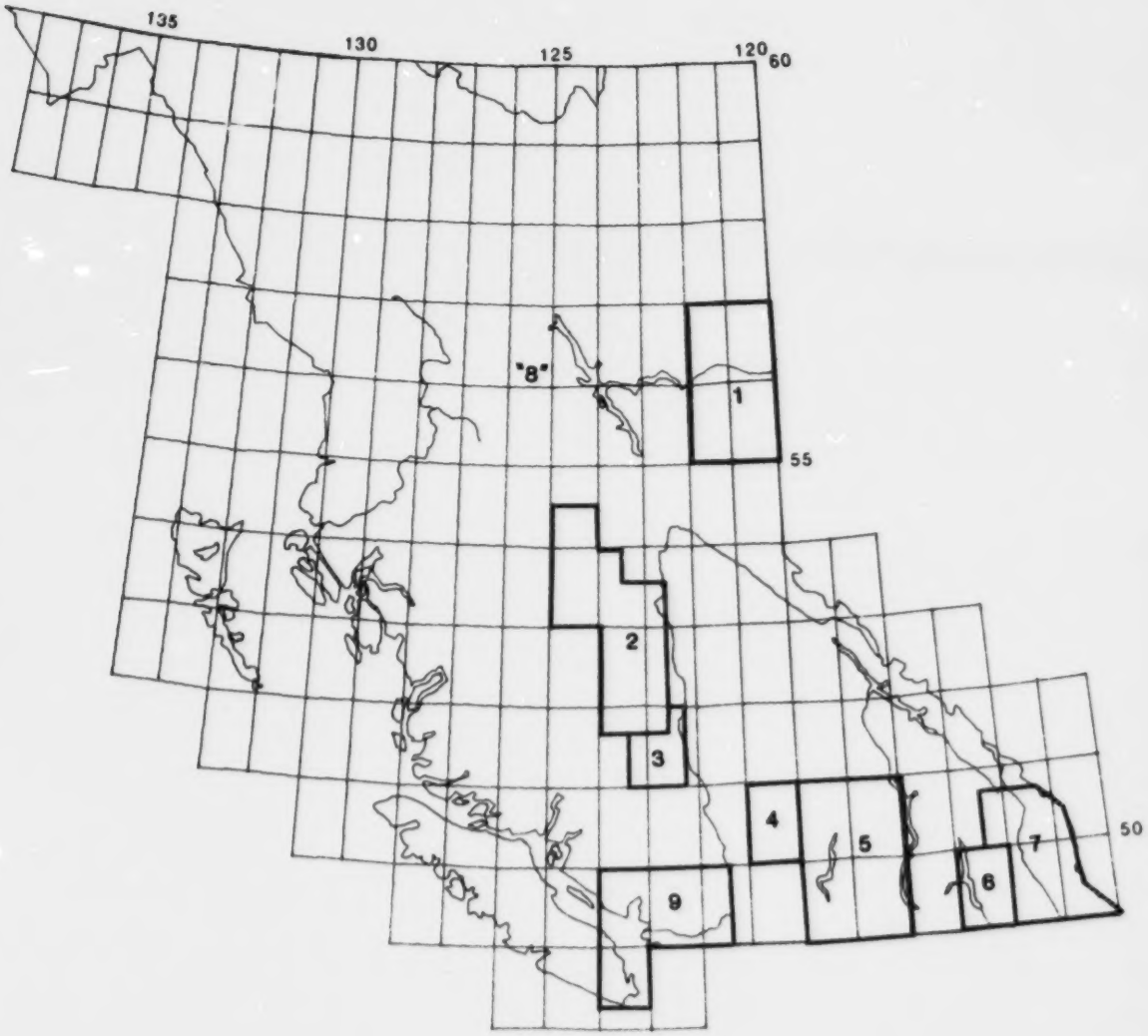

Figure 1. Location of the banding areas delineated for duck banding in British Columbia

outside the province were analysed using similar procedures. However, only direct returns were considered because birds returned indirectly may have wandered widely and may no longer be part of the original banded population.

Canada Goose returns were treated in a similar manner except that the banding reference areas were selected differently. The number of returns was first plotted by degree block of banding. That allowed the grouping of degree blocks within certain geographic areas that, because of the similarity of habitat might have supported a discrete population of geese. The resulting areas and the numbers of returns from each are shown in Table 2. The degree blocks included in each area are shown in Figure 2 for large Canada Geese and Figure 3 for small Canada Geese.

RESULTS AND DISCUSSION

General band recovery synopsis

Between 1951 and 1984 approximately 29,000 ducks were banded in British Columbia (Table 3 and Appendix 1). The most frequently banded birds were Mallard (23.9%), Barrow's Goldeneye (22.3%), Lesser Scaup (10.2%), Wood Duck (8.2%), Wigeon (9.3%) and Blue-winged Teal (7.2%). The majority of the Mallards (63.1%) and the Wood Ducks (88.1%) were banded on the coast. Most (93.4%) of the Blue-winged Teal were banded in the interior prior to 1970, and most of the Lesser Scaup (86.2%) and Barrow's Goldeneye (91.9%) were banded in the interior and most prior to 1960. A total of 3,747 bands of the major duck species have been recovered, for a return rate of 14.1% (Tables 4 and 5). Birds banded in the interior accounted for 76.6% of the returns.

Table 2. Geographic areas in which Canada Goose banding has occurred in British Columbia, and the number of returns in each area, 1951-1985.

Geographic Area	Number banded		Number of returns	Return rate (%)
	All status	Status 300[1]	All status	All status
Vanderhoof	971	869	156	16.1
Chilcotin Plateau	2210	76	211	9.5
100 Mile House	375	284	96	25.6
Kamloops	27	25	2	7.4
Okanagan	972	971	245	25.2
West Kootenays	9	0	2	22.2
East Kootenays	67	51	138	29.9
Southwest Coast	4785	905	1288	26.9
Northern Vancouver Island	87	0	44	50.6
Other	4	0	0	0
Total	9507	3181	2165	22.8

1. Status 300 are normal wild-caught birds. Birds of other status may include experimental and transplanted birds.

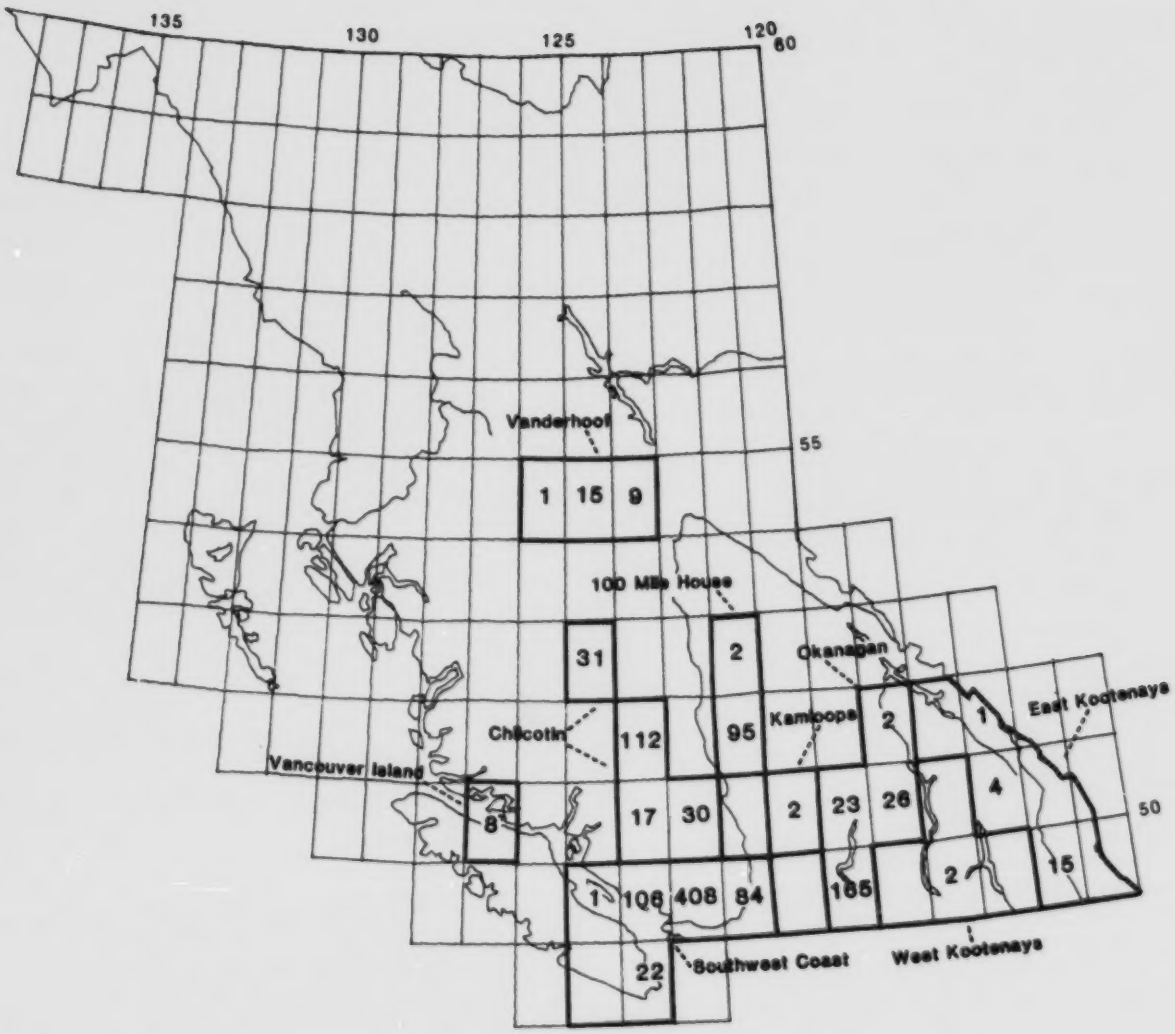

Figure 2. Numbers of large Canada geese returned by degree block of banding.

Figure 3. Numbers of small Canada geese returned by degree block of banding.

Table 3. Total numbers of the major species of ducks banded in British Columbia from 1951-1984. Includes birds of all status.

Species	Number banded	Locations
Mallard	6836	Approx. 63% were banded in Ladner during hunting season.
Gadwall	606	Most banded in the Fraser Valley
Wigeon	2659	Approx. 45% were banded in Ladner during hunting season.
Green-winged Teal	754	Most banded in Kamloops and Cariboo area, late 1950's.
Blue-winged Teal	2059	Most banded in Kamloops and Cariboo area, late 1950's and some in Creston in 1968.
Shoveler	222	Most banded in Cariboo, 1950's.
Pintail	1176	Approx. 36% were banded in Ladner, during hunting season. Kamloops, Cariboo, Vanderhoof are other areas of concentration.
Wood Duck	2354	Most banded in the Fraser Valley
Redhead	759	Cariboo, Kamloops and Creston were major banding areas.
Canvasback	164	Most banded in Cariboo in 1950's.
Lesser Scaup	2914	Most banded in Kamloops/Cariboo area through 1950's.
Barrow's Goldeneye	6383	Most banded in Cariboo, fewer in Kamloops, and some in E. Kootenays and Valemont.
Bufflehead	1763	Most banded in Cariboo.
Total banded	25722	

Table 4. Number of recoveries of the major species of ducks banded in British Columbia from 1951 to 1984, by banding location. Includes birds of all status.

Species	Area[1] 1	2	3	4	5	6	7	8	9
Mallard	11	113	56	224	9	54	39	7	708
Gadwall	-	-	-	12	-	-	-	2	22
Wigeon	8	122	39	89	3	1	-	-	109
Green-winged Teal	1	33	1	22	-	-	-	2	6
Blue-winged Teal	40	-	18	28	-	9	-	-	4
Shoveler	1	15	7	8	-	-	-	-	2
Pintail	1	37	3	25	-	-	-	-	48
Wood Duck	-	-	-	-	-	12	-	-	60
Redhead	-	56	17	34	4	15	1	-	-
Canvasback	-	27	1	-	-	-	-	-	-
Lesser Scaup	-	185	39	159	-	-	-	-	10
Barrow's Goldeneye	-	381	97	500	2	-	9	7	-
Bufflehead	-	45	113	30	-	-	3	-	-
Total birds recovered	62	1014	391	1119	18	79	52	16	888

1 1 Ft. St. John
2 Williams Lake
3 70 Mile House
4 Kamloops
5 Okanagan
6 Creston
7 East Kootenays
8 Rest of the province
9 Coast

Table 5. Band return rates for the major species of ducks banded in the interior and on the coast of British Columbia between 1951 and 1984.

Species	Location and return rate					
	Interior			Coast		
	# banded	# returned	return rate (%)	# banded	# returned	return rate (%)
Mallard	2523	513	20.3	4313	708	16.4
Gadwall	85	14	16.5	102	22	21.6
Wigeon	1455	262	18.0	1204	109	9.1
Green-winged Teal	629	59	9.4	125	6	4.8
Blue-winged Teal	2003	95	4.7	56	4	7.1
Shoveler	201	31	15.4	21	2	9.5
Pintail	693	66	9.5	483	48	9.9
Wood Duck	75	12	16.0	555	60	9.5
Redhead	759	127	16.7	-	-	-
Canvasback	164	28	17.1	-	-	-
Lesser Scaup	2575	383	14.9	339	10	2.9
Barrow's Goldeneye	6383	996	15.6	-	-	-
Bufflehead	1763	191	10.8	7	-	0
Total	19308	2777	14.4	7239	970	13.4

Recoveries by Species

Mallard

The recovery patterns of Mallards banded in the interior reference area are shown in Figures 4 and 5, and for the coastal area in Figures 6 and 7. Additional returns that could not be plotted from the interior area included one direct return from Louissiana and one from Illinois. Additional indirect returns included two from Kansas and one from North Dakota. Additional returns from the coast included one direct and three indirect returns from Alaska, and one indirect return from Arkansas. Most direct returns from the interior were local (45.4%) or from within British Columbia (59.5%). The only other area of importance was Washington (27.4% of returns). Indirect recoveries showed a slightly different pattern: 12.0% were returned in the area of banding, 30.6% were returned in British Columbia and 41.5% were returned in Washington. That would seem to indicate that locally produced Mallards do not show a great deal of site fidelity from one year to the next.

Local and hatching year males and females banded in the interior formed the highest proportion of the direct harvest (Table 6). However, hatching year males were the least represented of the indirect recoveries, while local and hatching year females occurred in the highest proportion. Hatching year birds were most vulnerable to local (within the province) direct harvest. Hatching year males probably do not return to the natal area, or perhaps not even to the province, and hence form a low proportion of the indirect harvest. After hatching year birds were returned less frequently in British Columbia than hatching year birds, and after hatching year males were returned in lowest numbers for both direct and indirect returns.

The proportion of direct recoveries of after hatching year females was nearly as high as those of local birds within the province, probably indicating high local vulnerability. The relatively low proportions of

Table 6. Summary of relative distribution of Mallard recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

Banded as[1]	Recovered								
	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	54	83	65.1	3	39	7.7	57	122	46.7
L, HYF	53	92	57.6	16	35	45.7	69	127	54.3
All L, HY[2]	160	259	61.8	28	99	28.3	188	358	52.5
AHYM	17	37	45.9	8	45	17.8	25	82	30.5
AHYF	17	35	48.6	5	27	18.5	22	62	35.5
All AHY[2]	35	73	47.9	13	73	17.8	48	146	32.9
Total birds all age, sex and unknown	195	332	58.7	41	172	23.8	236	504	46.8

1. L=Local bird: bird known to have been produced at the banding location.
   HYM/F=Hatching year male/female: young of the year but flighted when banded.
   AHYM/F=After hatching year male/female: more than 1 year old when banded.
   All L, HY, AHY: includes birds of unknown sex.

2. Totals may include birds of unknown sex.

Figure 4. The distribution of direct returns of Mallards banded in the interior of British Columbia between 1951 and 1984.

Figure 5. The distribution of indirect returns of Mallards banded in the interior of British Columbia between 1951 and 1984.

Figure 6. The distribution of direct returns of Mallards banded on the coast of British Columbia between 1951 and 1984.

Figure 7. The distribution of indirect returns of Mallards banded on the coast of British Columbia between 1951 and 1984.

indirect returns of after hatching year birds in British Columbia may reflect lowered survival or it may indicate low fidelity to breeding areas by older birds. The low return rates in British Columbia, both direct and indirect, of after hatching year males undoubtedly reflects the greater mobility of that age/sex class, as most drake Mallards move to molting areas away from the breeding ponds. Because most interior areas have not been subjected to intensive banding for approximately 20 years, return rates by age and sex of banded Mallards may be different today. Regulations were modified some time ago to correct a perceived over-harvest of local birds (B. Munro, pers. com.). However, the effects of those changes were not adequately monitored and will have to be assessed by an increased banding effort in the near future.

Most direct returns on the coast (73.6%) were from within the banding area or in the degree-block immediately to the south (17.0%). Indirect returns were also primarily from the banding area (71.2%) but other locations of interest included coastal Alaska and various parts of Alberta. This would indicate that Mallards wintering on the British Columbia southwest coast show strong site fidelity to the winter area, both within and between years, and that they breed in a widespread area of northwestern North America.

Coastal wintering Mallards were harvested within British Columbia at approximately equal rates regardless of age or sex (Table 7). A slightly lower proportion of birds banded as young of the year were harvested in British Columbia indirectly than were taken directly. That probably indicates movement to other wintering areas from one year to the next, by that age class. After hatching year males were also returned less frequently in British Columbia indirectly than as direct returns. However after hatching year females were encountered as indirect returns proportionately more often than as direct returns. It would seem that adult males may also select alternate wintering areas to some extent, but adult females are less likely

Table 7. Summary of relative distribution of Mallard recoveries, by age and sex, for birds banded on the coast of British Columbia between 1951 and 1984.

Banded as[1]	Recovered								
	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	59	78	75.6	33	45	73.3	92	123	74.8
L, HYF	61	77	79.2	27	39	69.2	88	116	75.9
All L, HY[2]	123	158	77.8	62	86	72.1	185	244	75.8
AHYM	39	52	75	25	38	65.8	64	90	71.1
AHYF	44	62	71	33	42	78.6	77	104	74
All AHY[2]	83	114	72.8	58	80	72.5	141	194	72.7
Total birds all age, sex and unknown	206	272	75.7	120	166	72.3	326	438	74.4

1,2. Abbreviations and explainations as in Table 6.

to.

The distribution patterns of direct returns of Mallards banded in Alberta, Mackenzie District, Yukon and Alaska are shown in Figures 8 to 11. Birds from Alberta were returned most often on the southwest coast (44.8%), or the southern part of the province generally. The birds came mainly from the Grande Prairie area and to a lesser extent from central and southern Alberta. Mallards coming from the Mackenzie District (only one banding location) were returned on the coast (30.0%) or in the southeastern part of the province (70%). Mallards banded in Yukon came from the Old Crow Flats or Nisutlin Bay and were returned mainly on the southwest coast. Birds from Alaska originated in widely separated parts of that state. Most returns were on the coast (77.3% - Queen Charlotte Islands, Vancouver Island, Vancouver area), or just east of the coast range.

In general, birds returned in British Columbia banded elsewhere originated over a large part of western North America. Nearly 42% of those returns have occurred in the two degree blocks enclosing the Fraser River delta. To some extent that may reflect the density of hunters in the Vancouver area, but that in turn also is an indication of the importance of that area to migrating and wintering waterfowl.

Figure 8. The distribution of direct returns in British Columbia of Mallards banded in Alberta.

Figure 9. The distribution of direct returns in British Columbia of Mallards banded in Mackenzie District.

Figure 10. The distribution of direct returns in British Columbia of Mallards banded in Yukon.

Figure 11. The distribution of direct returns in British Columbia of Mallards banded in Alaska.

Gadwall

The recovery patterns of normal wild Gadwall banded in the interior and coastal reference areas are shown in Figures 12 to 15. Most (71.4%) direct and indirect returns (57.1%) from the interior were outside British Columbia. Consequently direct returns of birds banded on the coast were mostly from the area of banding (60.0%). An additional 55 returns were examined of birds that were classified as hand reared game farm birds. Most of those had been released in the coastal area and returned in the degree blocks of banding.

Tables 8 and 9 show the relative contribution each age and sex class made to the recovery distribution, for those band returns that could be so classified. Local and hatching year birds formed the majority or all of the returns of birds banded on the coast or in the interior, respectively.

Table 8. Summary of relative distribution of Gadwall recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

	Recovered								
Banded as[1]	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	1	2	50	0	2	0	1	4	25
L, HYF	0	2	0	3	3	100	3	5	60
All L, HY[2]	2	7	28.6	3	7	42.9	5	14	35.7
AHYM	0	0	0	0	0	0	0	0	0
AHYF	0	0	0	0	0	0	0	0	0
All AHY[2]	0	0	0	0	0	0	0	0	0
Total birds all age, sex and unknown	2	7	28.6	3	7	42.9	5	14	35.7

1,2. Abbreviations and explainations as in Table 6.

Table 9. Summary of relative distribution of Gadwall recoveries, by age and sex, for birds banded in the coast of British Columbia between 1951 and 1984.

	Recovered								
Banded as[1]	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	4	9	44.4	2	5	40	6	14	42.9
L, HYF	4	5	80	0	1	0	4	6	66.7
All L, HY[2]	8	14	57.1	2	6	33.3	10	20	50
AHYM	0	0	0	0	0	0	0	0	0
AHYF	0	0	0	1	1	100	1	1	100
All AHY[2]	0	0	0	1	1	100	1	1	100
Total birds all age, sex and unknown	8	14	57.1	3	7	42.9	11	21	52.4

1,2. Abbreviations and explainations as in Table 6.

Figure 12. The distribution of direct returns of Gadwall banded in the interior of British Columbia between 1951 and 1984.

Figure 13. The distribution of indirect returns of Gadwall banded in the interior of British Columbia between 1951 and 1984.

Figure 14. The distribution of direct returns of Gadwall banded on the coast of British Columbia between 1951 and 1984.

Figure 15. The distribution of indirect returns of Gadwall banded on the coast of British Columbia between 1951 and 1984.

Wigeon

The recovery patterns of Wigeon banded in the interior reference area are shown in Figures 16 and 17, and for the coastal area in Figures 18 and 19. Additional returns from the interior area not plotted included one direct return from Texas and one from Mexico. Additional returns from the coast included five direct returns from Alaska. Most direct returns were from outside British Columbia: Washington - 21.8%, Oregon - 27.9%, and California - 22.9%. British Columbia accounted for only 21.8% of the returns, and most of those (64.1%) were in the immediate area of banding. Indirect returns showed a similar pattern, with 21.2% returned in British Columbia, 24.2% in Washington, 18.2% in Oregon and 33.3% in California. Wigeon breeding in British Columbia appear to migrate well before hunting season and move considerable distances (Oregon and California).

Local and hatching year birds banded in the interior formed the largest proportion of both the direct and indirect harvest (Table 10). Young females were slightly more vulnerable, although a large proportion of young birds banded were not sexed.

Most direct and indirect returns on the coast were from within the banding area (70.4% and 59.4%, respectively). Almost all direct returns (92.6%) and most (84.1%) indirect returns were from the Strait of Georgia-Puget Sound area. As with Mallards, this would seem to indicate the importance of the Vancouver area to over-wintering Wigeon, and that there is considerable fidelity between years.

After hatching year birds formed a greater proportion of the harvest on the coast, for both direct and indirect returns (Table 11). However, that may to a large extent be a reflection of the banding dates and not a true indication of higher vulnerability. In late fall Wigeon become very difficult to age and can be erroneously placed in the adult category. Similarly, in the

Table 10. Summary of relative distribution of Wigeon recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

	Recovered								
Banded as[1]	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	2	25	8	0	8	0	2	33	6.1
L, HYF	3	28	10.7	3	9	33.3	6	37	16.2
All L, HY[2]	31	154	20.1	8	52	15.4	39	206	18.9
AHYM	2	16	12.5	3	11	27.3	5	27	18.5
AHYF	2	11	18.2	0	4	0	2	15	13.3
All AHY[2]	4	28	14.3	4	16	25	8	44	18.2
Total birds all age, sex and unknown	35	182	19.2	12	68	17.6	47	250	18.8

1,2. Abbreviations and explainations as in Table 6.

Table 11. Summary of relative distribution of Wigeon recoveries, by age and sex, for birds banded on the coast of British Columbia between 1951 and 1984.

	Recovered								
Banded as[1]	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	4	4	100	8	12	66.7	12	16	75
L, HYF	2	6	33.3	7	9	77.8	9	15	60
All L, HY[2]	6	10	60	15	21	71.4	21	31	67.7
AHYM	8	10	80	18	27	66.7	26	37	70.3
AHYF	5	6	83.3	10	13	76.9	15	19	78.9
All AHY[2]	13	16	81.3	28	40	70	41	56	73.2
Total birds all age, sex and unknown	19	26	73.1	43	61	70.5	62	87	71.3

1,2. Abbreviations and explainations as in Table 6.

Figure 16. The distribution of direct returns of Wigeon banded in the interior of British Columbia between 1951 and 1984.

Figure 17. The distribution of indirect returns of Wigeon banded in the interior of British Columbia between 1951 and 1984.

Figure 18. The distribution of direct returns of Wigeon banded on the coast of British Columbia between 1951 and 1984.

Figure 19. The distribution of indirect returns of Wigeon banded on the coast of British Columbia between 1951 and 1984.

new calendar year all birds can be classed as after hatching year even though they are not yet one year old.

A number of Wigeon returns have occurred in British Columbia from birds banded in Alberta (11), Mackenzie District (1), Yukon (1) and Alaska (57). Returns from birds banded in Alberta came from two major areas: the Grande Prairie area and the east central area, east of Calgary and Edmonton. Grande Prairie birds were returned mostly on the coast while those from east central Alberta were widely scattered in the southern part of the province. Birds banded in Alaska came from the Yukon Flats, the Tanana River valley and the Yukon-Kuskokwim delta. Most (70%) returns were coastal, the rest being scattered through the central and southern interior (Figures 20 and 21).

Figure 20. The distribution of direct returns in British Columbia of Wigeon banded in Alberta, Mackenzie District and Yukon.

Figure 21. The distribution of direct returns in British Columbia of Wigeon banded in Alaska.

Green-winged Teal

Recovery patterns of Green-winged Teal banded in the interior areas are shown in Figures 22 and 23. Additional direct returns from the interior not plotted included one each from South Dakota, Oklahoma, Louisiana, New Mexico and Mexico. Returns of Green-winged Teal are relatively few. Direct returns from the interior were generally south of British Columbia, most (61.1%) from California. Some indirect returns occurred in British Columbia (12.5%), but most again (56.3%) were from California.

Hatching year and after hatching year birds banded in the interior were returned directly about equally, while after hatching year birds were returned more often indirectly (Table 12).

Very few bands have been returned from birds banded in the coastal area, directly or indirectly (6 in total). All but one return was south of the banding area, indicating that Green-winged Teal do not generally winter in the Vancouver area. Although these data are sparse, they are supported by recent intensive survey efforts in the Vancouver area, which also show green-winged teal to be transients rather than winter residents (McKelvey et al. 1985:61). Band recoveries in British Columbia of Green-winged Teal banded elsewhere have similarly been few (Fig. 24). Most (8) came from Alaska (widely scattered), with one each from Alberta and Yukon. Sixty percent of the returns were coastal, the rest were in the interior.

Table 12. Summary of relative distribution of Green-winged Teal recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

Banded as[1]	Recovered								
	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	0	6	0	0	1	0	0	7	0
L, HYF	0	8	0	1	3	33.3	1	11	9.1
All L, HY[2]	0	21	0	1	6	16.7	1	27	3.7
AHYM	0	15	0	0	8	0	0	23	0
AHYF	0	1	0	1	2	50	1	3	33.3
All AHY[2]	0	20	0	1	10	10	1	30	3.3
Total birds all age, sex and unknown	0	41	0	2	16	12.5	2	57	3.5

1,2. Abbreviations and explainations as in Table 6.

Figure 22. The distribution of direct returns of Green-winged Teal banded in the interior of British Columbia between 1951 and 1984.

Figure 23. The distribution of indirect returns of Green-winged Teal banded in the interior of British Columbia between 1951 and 1984.

Figure 24. The distribution of direct returns in British Columbia of Green-winged Teal banded in Alberta, Yukon and Alaska.

Blue-winged Teal

Recoveries of Blue-winged Teal banded in the interior are shown in Figures 25 and 26. Only one Blue-winged Teal has been returned from banding on the coast and that was recovered in Texas. Other returns not plotted included direct returns from Manitoba (1), South Dakota (1), Florida (1), Louisiana (2), Texas (1), Mexico (7), Cuba (1), Puerto Rica (1), Honduras (1), and Columbia (1). Indirect returns were from Louisiana (3), Texas (3), Mexico (9), Cuba (1), Honduras (1), Guatamela (2), and Columbia (1). Most direct recoveries of Blue-winged Teal (73.2%) were from within British Columbia. Other direct returns were widely scattered to the south and southeast, as is typical of the migration pattern of blue-winged teal (Bellrose 1976). Indirect returns were also predominantly to the southeast with only 8% being in British Columbia. Hatching year birds formed the highest proportion of direct returns, while both age classes were returned approximately equally indirectly (Table 13). Three birds have been returned in British Columbia from birds banded in Alberta (Figure 27).

Table 13. Summary of relative distribution of Blue-winged Teal recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

Banded as[1]	Recovered								
	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	1	4	25	0	1	0	1	5	20
L, HYF	1	2	50	0	4	0	1	6	16.7
All L, HY[2]	27	43	62.8	1	14	7.1	28	57	49.1
AHYM	0	8	0	0	8	0	0	16	0
AHYF	4	8	50	1	4	25	5	12	41.7
All AHY[2]	4	16	25	1	12	8.3	5	28	17.9
Total birds all age, sex and unknown	31	59	52.5	2	26	7.7	33	85	38.8

1,2. Abbreviations and explainations as in Table 6.

Figure 25. The distribution of direct returns of Blue-winged Teal banded in the interior of British Columbia between 1951 and 1984.

Figure 26. The distribution of indirect returns of Blue-winged Teal banded in the interior of British Columbia between 1951 and 1984.

Figure 27. The distribution of direct returns in British Columbia of Blue-winged Teal banded in Alberta.

Shoveler

Recovery patterns of Shovelers banded in the interior are shown in Figures 28 and 29. One indirest return from Mexico was not plotted. The distribution of direct returns for all interior areas was: California - 50%; British Columbia - 25%; and Washington and Oregon combined - 25%. Indirect returns showed a similar pattern. Hatching year birds accounted for almost all (96.7%) of the returns, both direct and indirect (Table 14).

Returns from birds banded in Alaska have been in the interior or on the coast (Figure 30), and they originated on the Tanana River or the Yukon Flats. The single return from Alberta came from near Red Deer.

Table 14. Summary of relative distribution of Shoveler recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

Banded as[1]	Recovered								
	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	0	3	0	0	1	0	0	4	0
L, HYF	1	4	25.5	0	1	0	1	5	20.5
All L, HY[2]	5	19	26.8	0	10	0	5	29	17.7
AHYM	0	1	0	0	0	0	0	1	0
AHYF	0	0	0	0	0	0	0	0	0
All AHY[2]	0	1	0	0	0	0	0	1	0
Total birds all age, sex and unknown	5	20	25.5	0	10	0	5	30	17.1

1,2. Abbreviations and explainations as in Table 6.

Figure 28. The distribution of direct returns of Shovelers banded in the interior of British Columbia between 1951 and 1984.

Figure 29. The distribution of indirect returns of Shovelers banded in the interior of British Columbia between 1951 and 1984.

Figure 30. The distribution of direct returns in British Columbia of Shovelers banded in Alberta and Alaska.

Pintail

The recovery patterns of Pintails banded in the interior are shown in Figures 31 and 32, and for returns from the coastal reference area in Figures 33 and 34. Direct returns not plotted from the interior included one each from Louisiana, Mexico and Panama, while indirect returns not plotted included one from Illinois, one from Oklahoma and two from Texas. Direct returns not plotted from the coast included one from Illinois and one from Louisiana. Additional indirect returns from the coast included one from Arkansas. Direct and indirect returns from the interior have been primarily south of British Columbia, with California being the most important area for each (43.5% and 60.6%, respectively). British Columbia accounted for only 8.7% and 6.1% of the direct and indirect returns, respectively. Indirect returns showed a slightly more eastward shift in distribution. Hatching year birds predominated in the direct harvest, while both age classes were about equally represented in the indirect harvest (Table 15).

Direct returns from the coastal area were from within the degree block of banding (28.6%) or within one degree of the banding location (62.9%). Indirect returns tended to be south of the banding degree block (62.5%), indicating only moderate levels of wintering-site fidelity. Hatching year birds were harvested more heavily, both directly and indirectly (Table 16). Hatching year males were returned directly slightly more frequently than females, but the reverse was true for indirect returns.

Pintails banded outside British Columbia (Figures 35 and 36) have been returned predominately on the coast (76.9%). Those from Alberta were from the Grande Prairie area or the south central and east central parts of Alberta. Birds banded in Alaska came from the lower Yukon River, the Minto Flats area and the Yukon Flats. One bird was banded near the tip of the Aleutian Islands and encountered as a direct return on Vancouver Island.

Table 15. Summary of relative distribution of Pintail recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

	Recovered								
Banded as[1]	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	0	3	0	0	3	0	0	6	0
L, HYF	0	5	0	0	4	0	0	9	0
All L, HY[2]	1	17	5.9	1	20	5	2	37	5.4
AHYM	0	4	0	0	10	0	0	14	0
AHYF	1	5	20	1	7	14.3	2	12	16.7
All AHY[2]	1	9	11.1	1	17	5.9	2	26	7.7
Total birds all age, sex and unknown	2	26	7.7	2	37	5.4	4	63	6.3

1,2. Abbreviations and explainations as in Table 6.

Table 16. Summary of relative distribution of Pintail recoveries, by age and sex, for birds banded on the coast of British Columbia between 1951 and 1984.

	Recovered								
Banded as[1]	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	7	17	41.2	0	1	0	7	18	38.9
L, HYF	7	14	50	3	4	75	10	18	55.6
All L, HY[2]	15	32	46.9	3	5	60	18	37	48.6
AHYM	0	2	0	0	3	0	0	5	0
AHYF	0	2	0	0	0	0	0	2	0
All AHY[2]	0	4	0	0	3	0	0	7	0
Total birds all age, sex and unknown	15	36	41.7	3	8	37.5	18	44	40.9

1,2. Abbreviations and explainations as in Table 6.

Figure 31. The distribution of direct returns of Pintail banded in the interior of British Columbia between 1951 and 1984.

Figure 32. The distribution of indirect returns of Pintail banded in the interior of British Columbia between 1951 and 1984.

Figure 33. The distribution of direct returns of Pintail banded on the coast of British Columbia between 1951 and 1984.

Figure 34. The distribution of indirect returns of Pintail banded on the coast of British Columbia between 1951 and 1984.

Figure 35. The distribution of direct returns in British Columbia of Pintail banded in Alaska.

Figure 36. The distribution of direct returns in British Columbia of Pintail banded in Mackenzie District, Yukon and Alberta.

Wood Duck

The recovery patterns of Wood Ducks banded on the coast and in the interior are shown in Figures 37 to 40. Most direct returns from both reference areas were outside British Columbia (62.1% and 77.8%, respectively). Indirect returns were predominantly from within British Columbia for coastal banded birds (58.1%) and were exclussively from outside the province for interior banded birds. California and Oregon were the main areas of return south of British Columbia (50% of all returns). Hatching year birds formed all of the return sample for birds banded in the interior and males predominated (Table 17).

After hatching year birds formed a slightly larger portion of the returns from the coastal area, both direct and indirect (Table 18). Males of all age classes were returned more frequently than females.

Table 17. Summary of relative distribution of Wood Duck recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

	Recovered								
Banded as[1]	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	2	5	40	0	2	0	2	7	28.6
L, HYF	0	4	0	0	1	0	0	5	0
All L, HY[2]	2	9	22.2	0	3	0	2	12	16.7
AHYM	0	0	0	0	0	0	0	0	0
AHYF	0	0	0	0	0	0	0	0	0
All AHY[2]	0	0	0	0	0	0	0	0	0
Total birds all age, sex and unknown	2	9	22.2	0	3	0	2	12	16.7

1,2. Abbreviations and explainations as in Table 6.

Table 18. Summary of relative distribution of Wood Duck recoveries, by age and sex, for birds banded on the coast of British Columbia between 1951 and 1984.

	Recovered								
Banded as[1]	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	3	7	42.9	3	7	42.9	6	14	42.9
L, HYF	0	4	0	0	1	0	0	5	0
All L, HY[2]	4	14	28.6	4	10	40	8	24	33.3
AHYM	4	8	50	4	7	57.1	8	15	53.3
AHYF	3	7	42.9	2	6	33.3	5	13	38.5
All AHY[2]	7	15	46.7	6	13	46.2	13	28	46.4
Total birds all age, sex and unknown	11	29	37.9	10	23	43.5	21	52	40.4

1,2. Abbreviations and explainations as in Table 6.

Figure 37. The distribution of direct returns of Wood Duck banded in the interior of British Columbia between 1951 and 1984.

Figure 38. The distribution of indirect returns of Wood Duck banded in the interior of British Columbia between 1951 and 1984.

Figure 39. The distribution of direct returns of Wood Duck banded on the coast of British Columbia between 1951 and 1984.

Figure 40. The distribution of indirect returns of Wood Duck banded on the coast of British Columbia between 1951 and 1984.

Redhead

The recovery patterns of Redheads banded in the interior are shown in Figures 41 and 42. No birds have been banded on the coast. Additional direct returns not plotted included one from Wisconsin, 10 from Texas and one from Mexico. Indirect returns not plotted included one each from Ontario, Minnisota, North Dakota and South Dakota, two from Texas and three from Mexico. Most direct recoveries of birds banded in the interior were from British Columbia (59.2%), Washington (14.1%) or California (14.1%). Returns in British Columbia were predominantly near the area in which the birds were banded (85.7%). Indirect returns were fewer than direct returns, and they were shifted towards the east. Just over half the indirect returns were in British Columbia (52.4%). Hatching year birds were returned directly much more frequently than after hatching year birds (Table 19), while the reverse was true for indirect returns. Differential return rates by sex were obscured by the large number of returns of unsexed hatching year birds.

Table 19. Summary of relative distribution of Redhead recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

Banded as[1]	Recovered								
	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	2	8	25	0	1	0	2	9	22.2
L, HYF	6	8	75	0	3	0	6	11	54.5
All L, HY[2]	33	63	52.4	5	13	38.5	38	76	50
AHYM	4	8	50	4	9	44.4	8	17	47.1
AHYF	5	14	35.7	2	11	18.2	7	25	28
All AHY[2]	9	22	40.9	6	20	30	15	42	35.7
Total birds all age, sex and unknown	42	85	49.4	11	33	33.3	53	118	44.9

1,2. Abbreviations and explainations as in Table 6.

Figure 41. The distribution of direct returns of Redhead banded in the interior of British Columbia between 1951 and 1984.

Figure 42. The distribution of indirect returns of Redhead banded in the interior of British Columbia between 1951 and 1984.

Canvasback

The recovery patterns of Canvasbacks banded in interior are shown in Figures 43 and 44. No band returns have been encountered from birds banded on the coast. Two additional direct returns were not plotted, one from Maryland and one from Texas. Direct returns have been from California (45.2%), Washington (22.6%), and Oregon and British Columbia (16.1% each). British Columbia returns were all from near the banding area. Most returns in the United States were from coastal areas. Indirect returns have only come from British Columbia (40%) and California (60%). Hatching year birds predominated in both the direct and indirect harvest (Table 20).

Canvasback banded elsewhere and returned in British Columbia have come from Alberta (1) and Alaska (17) (Figure 45). The return from Alberta was of a bird banded near Athabaska Lake, probably the Peace-Athabaska delta. Those from Alaska came from east central Alaska, near Yukon Flats, Minto Flats and the Tetlin Lake area. Most recoveries were in the southwest corner of the province, 61.1% within one degree-block of Vancouver.

Table 20. Summary of relative distribution of Canvasback recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

Banded as[1]	Recovered								
	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	1	5	20	0	1	0	1	6	16.7
L, HYF	0	4	0	2	2	100	2	6	33.3
All L, HY[2]	4	30	13.3	4	8	50	8	38	21.1
AHYM	0	0	0	0	0	0	0	0	0
AHYF	1	3	33.3	0	1	0	1	4	25
All AHY[2]	1	3	33.3	0	2	0	1	5	20
Total birds all age, sex and unknown	5	33	15.2	4	10	40	9	43	20.9

1,2. Abbreviations and explainations as in Table 6.

Figure 43. The distribution of direct returns of Canvasback banded in the interior of British Columbia between 1951 and 1984.

Figure 44. The distribution of indirect returns of Canvasback banded in the interior of British Columbia between 1951 and 1984.

Figure 45. The distribution of direct returns in British Columbia of Canvasback banded in Alberta and Alaska.

Lesser Scaup

The recovery patterns of Lesser Scaup banded in the interior are shown in Figures 46 and 47. Additional direct returns from the interior came from Saskatchewan (1), Illinois (1), Ohio (1), Minnisota (1), North Dakota (1), Nebraska (2), Mississippi (1), Louisiana (3), Texas (5) and Mexico (6). Additional indirect returns came from Saskatchewan (1), Minnesota (1), Kanasas (2), Florida (1), Louisiana (1) and Mexico (6). Direct returns of Lesser Scaup were spread widely throughout southern British Columbia and the Pacific states. British Columbia had 21.8% of the returns, with most of those (80.3%) being local returns. Washington and Oregon had 15.0% and 9.5% of the returns, respectively, with many of those returns being from interior areas. The largest percentage of returns came from California (49.1%), and the highest concentration of those returns was from the San Francisco Bay area (44.4% of California returns). Returns elsewhere in California were also widely dispersed, many coming from the interior.

Indirect returns from birds banded in the interior showed a similar pattern. Returns in British Columbia were primarily local (60%), some returns from Washington and Oregon were from inland areas, California had the majority of the returns (65.1%), and San Francisco Bay produced most of those returns (55.4%). Lesser Scaup appear to show considerable fidelity to both breeding and wintering areas, and their migration route seems to be more inland than coastal. Interestingly, although Lesser Scaup winter in the Fraser River delta area in considerable numbers (McKelvey et al. 1985) relatively few returns of Lesser Scaup banded in British Columbia have occurred there.

Hatching year birds formed the largest proportion of both the direct and indirect harvest of birds banded in the interior (Table 21). Males of both age groups were also returned more frequently, directly and indirectly, although that may be a reflection of the strongly male-favoured sex ratios in

Table 21. Summary of relative distribution of Lesser Scaup recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

Banded as[1]	Recovered								
	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	16	63	25.4	1	21	4.8	17	84	20.2
L, HYF	12	35	34.3	2	13	15.4	14	48	29.2
All L, HY[2]	52	201	25.9	7	67	10.4	59	268	22
AHYM	12	33	36.4	0	18	0	12	51	23.5
AHYF	2	19	10.5	3	12	25	5	31	16.1
All AHY[2]	14	59	23.7	3	35	8.6	17	94	18.1
Total birds all age, sex and unknown	66	260	25.4	10	102	9.8	76	362	21

1,2. Abbreviations and explainations as in Table 6.

Figure 46. The distribution of direct returns of Lesser Scaup banded in the interior of British Columbia between 1951 and 1984.

Figure 47. The distribution of indirect returns of Lesser Scaup banded in the interior of British Columbia between 1951 and 1984.

Lesser Scaup (Bellrose 1976).

Relatively few bands have been returned from birds banded in the coastal area (3 direct and 2 indirect). Of the direct returns one was local, one was from the interior of British Columbia (during the fall of the same calendar year it was banded), and one was from the northern California coast. Of the indirect returns, one was from near Kamloops, and one was from the San Francisco Bay area. Although the sample is small, 40.0% of the returns of birds banded on the coast were in the interior of the province which seems at odds with the return pattern of birds banded in British Columbia. Very few of those were recovered in the Vancouver area (1 of 306 direct and indirect returns).

Lesser Scaup have been returned in British Columbia that were banded in Alberta, Yukon and Alaska (Figure 48). Returns have been made throughout the interior, including the Atlin area, but the majority (57.1%) have been on the coast, and most of those from the Strait of Georgia area (89.9%). Most birds from Alaska came from the Yukon Flats area.

Figure 48. The distribution of direct returns in British Columbia of Lesser Scaup banded in Alberta, Yukon and Alaska.

Barrow's Goldeneye

The recovery patterns of Barrow's Goldeneye banded in the interior are shown in Figures 49 and 50. One additional direct from Ontario was not plotted. Barrow's Goldeneye direct returns were primarily from British Columbia (92.0%), and were frequently in the local banding area (67.8% of returns in British Columbia). Washington accounted for most of the other (5.9%) direct returns.

Indirect returns showed a similar pattern, but with a much large proportion of birds harvested on the coast. Of the indirect returns 91.6% were from within British Columbia: 40.2% of those were from the degree block of banding and 47.0% were from the coastal area. Clearly Barrow's Goldeneye show considerable breeding site fidelity, and a tendency to remain in British Columbia throughout the year.

Hatching year birds formed a much larger part of the direct harvest, but contributed about equally with adult birds to the indirect harvest (Table 22). There was little difference between the return rates of hatching year males and females, in both the direct and indirect harvest. After hatching year males formed a small portion of the harvest because they do not moult in the breeding areas and are not subjected to heavy local hunting pressure (Savard 1987).

Table 22. Summary of relative distribution of Barrow's Goldeneye recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

Banded as[1]	Recovered								
	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	80	88	90.9	9	12	75	89	100	89
L, HYF	71	75	94.7	16	19	84.2	87	94	92.6
All L, HY[2]	370	399	92.7	80	90	88.9	450	489	92
AHYM	20	24	83.3	4	5	80	24	29	82.8
AHYF	94	102	92.2	79	83	95.2	173	185	93.5
All AHY[2]	114	126	90.5	84	89	94.4	198	215	92.1
Total birds all age, sex and unknown	484	525	92.2	164	179	91.6	648	704	92

1,2. Abbreviations and explainations as in Table 6.

Figure 49. The distribution of direct returns of Barrow's Goldeneye banded in the interior of British Columbia between 1951 and 1984.

Figure 50. The distribution of indirect returns of Barrow's Goldeneye banded in the interior of British Columbia between 1951 and 1984.

Bufflehead

The recovery patterns of Bufflehead banded in the interior are shown in Figures 51 and 52. No Bufflehead have been banded in the coastal area. Direct recoveries from the interior have been from British Columbia (36.2%), Washington (40.0%) and California (15.2%). Most returns in British Columbia (71.1%) were from outside the banding degree block. Indirect returns occurred in about the same proportion as direct returns in British Columbia (34.0%) but returns in Washington were lower (31.9%) and those in California higher (23.4%), indicating a slightly more southern distribution.

Hatching year birds were returned much more frequently in the direct harvest; there was little discernible differential mortality by sex either directly or indirectly (Table 23). In the total harvest females were slightly more vulnerable.

Bufflehead have been returned in British Columbia that were banded in Alberta and in Alaska (Figures 53 and 54). Most returns were coastal (81.0%). Birds banded in Alberta have come from the Grande Prairie area and from near Cold Lake. Birds banded in Alaska have come from the Yukon Flats and from the Tanana River valley.

Table 23. Summary of relative distribution of Bufflehead recoveries, by age and sex, for birds banded in the interior of British Columbia between 1951 and 1984.

Banded as[1]	Recovered								
	Direct			Indirect			All recoveries		
	BC	Total	%BC	BC	Total	%BC	BC	Total	%BC
L, HYM	5	21	23.8	1	3	33.3	6	24	25
L, HYF	8	19	42.1	1	8	12.5	9	27	33.3
All L, HY[2]	26	75	34.7	5	23	21.7	31	98	31.6
AHYM	3	6	50	4	6	66.7	7	12	58.3
AHYF	4	17	23.5	6	17	35.3	10	34	29.4
All AHY[2]	7	23	30.4	10	23	43.5	17	46	37
Total birds all age, sex and unknown	33	98	33.7	15	46	32.6	48	144	33.3

1,2. Abbreviations and explainations as in Table 6.

Figure 51. The distribution of direct returns of Bufflehead banded in the interior of British Columbia between 1951 and 1984.

Figure 52. The distribution of indirect returns of Bufflehead banded in the interior of British Columbia between 1951 and 1984.

Figure 53. The distribution of direct returns in British Columbia of Bufflehead banded in Alberta.

Figure 54. The distribution of direct returns in British Columbia of Bufflehead banded in Alaska.

Canada Geese

The geographic pattern of both direct and indirect returns of geese banded in various parts of British Columbia are shown in Figures 55-63. Additional returns not plotted included, for geese banded in 100 Mile House one from the Northwest Territories; for geese banded in the Okanagan, one each from Wyoming and Nebraska, two from Saskatchewan and three from Colorado; and for geese banded in Vancouver one from Colorado. Large geese banded near Vanderhoof were returned locally (16%), on the coast of British Columbia, Washington and Oregon (32%), or in the Columbia basin (52%) (Figure 55). No geese were returned north of the banding location.

Geese banded in the Chilcotin (Figure 56) were returned locally (36%), in the Vancouver area (30%), in Washington (18%), or in Oregon (10%). Most Washington returns (74%) were from the Okanogan Valley. However no returns have been recorded in the Okanagan Valley of British Columbia. Approximately 4% of the returns were from the Fort St. John-Grande Prairie area, which may indicate a molt migration to northwestern Alberta.

Geese banded in the 100 Mile House area showed quite a different pattern of recoveries than those from the Chilcotin (Figure 57). Approximately the same proportion were local returns (23%), a larger proportion were from Washington (24%), few coastal returns were obtained, and the largest proportion was from southern Oregon and northern California (44%). There was also a northward and eastward component to the return pattern.

Returns of geese banded in the Kamloops area have been too few to indicate much about migration patterns (Figure 58). A larger banding effort in the Kamloops area seems warranted given the current density of geese in that area (personal observation and E. Hennan, pers. comm.).

Recoveries from geese banded in the Okanagan (Figure 59) have been from the local area (38%), from Washington (30%), mostly in the Okanogan Valley,

(66% of Washington returns), and from Alberta (11%). Lesser numbers have been returned from central Oregon (5%) and northern California (5%). Birds from the Okanagan have the most clearly defined southward and eastward pattern of recoveries of all geese banded in British Columbia. The eastward movement is probably a result of a molt migration to the north with an eastward shift on the return south.

Too few birds have been banded in the West Kootenays to indicate much about migration patterns of that population (Figure 60). The one return from southern Alberta is interesting because it fits the pattern of migration seen in birds from the Okanagan.

Geese banded in the East Kootenays have been returned primarily in the Columbia basin of eastern Washington (60%) (Figure 61). Most returns (85%) were south of the local area, perhaps indicating an under-utilized local resource.

Most geese banded in the Vancouver area have been returned locally (92%) (Figure 62). That reflects the sedentary nature of that recently introduced population, and also indicates its importance to local hunters. Areas south of Vancouver, in Washington and Oregon, have also benefited from that population.

Geese banded on northern Vancouver Island have also been returned most heavily in the local area (50%) (Figure 63). That population is also a recent introduction, in the Nimpkish Valley area, and also appears to be quite sedentary.

Small Canada Geese were apparently from the population nesting on the Alaska tundra, primarily Taverner's Canada Geese (Bellrose 1976). Most recoveries came from eastern Washington, in the Columbia basin (Figure 64), or from Alaska (8 returns).

Figure 55. Recoveries of large Canada Geese banded near Vanderhoof between 1951 and 1985.

Figure 56. Recoveries of large Canada Geese banded in the Chilcotin between 1951 and 1985.

Figure 57. Recoveries of large Canada Geese banded near 100 Mile House between 1951 and 1985.

Figure 58. Recoveries of large Canada Geese banded near Kamloops between 1951 and 1985.

Figure 59. Recoveries of large Canada Geese banded in the Okanagan between 1951 and 1985.

Figure 60. Recoveries of large Canada Geese banded in the West Kootenays between 1951 and 1985.

Figure 61. Recoveries of large Canada Geese banded in the East Kootenays between 1951 and 1985.

Figure 62. Recoveries of large Canada Geese banded near Vancouver between 1951 and 1985.

Figure 63. Recoveries of large Canada Geese banded on northern Vancouver Island between 1951 and 1985.

Figure 64. Recoveries of small Canada Geese banded near Vanderhoof between 1951 and 1985.

CONCLUSIONS

The sample of waterfowl banded in British Columbia is small and the total numbers returned correspondingly smaller. In addition no major banding effort has occurred for about 20 years. The most obvious conclusion to be drawn is that more banding is required. Such an effort would have several objectives: (1) determine if the band return distribution reported here has changed appreciably within the Pacific Flyway; (2) provide an estimate of harvest independent of the National Harvest Survey; (3) if the sample were large enough, provide assessments of productivity and survival rates of provincial populations.

Some other tentative conclusions about populations of waterfowl hunted in British Columbia can also be made. These are:

1. Locally produced Mallards are being harvested primarily by hunters in British Columbia and Washington. Hunters in southern British Columbia are being supplemented by birds from Alberta and Mackenzie District, and those on the coast and in the southwest by birds from Yukon and Alaska. Mallards found on the coast are wintering birds, rather than migrants.
2. Locally produced Wigeon are harvested primarily south of British Columbia. Most birds taken in British Columbia are from Alberta - harvested in southern British Columbia; from Mackenzie and Yukon - harvested in the southwest; and from Alaska - harvested throughout the interior and along the coast. Wigeon found on the coast remain to winter rather than moving farther south.
3. British Columbia Green-winged Teal are not harvested locally, but rather in Washington and California. Teal shot in the south and southwest have come from Yukon and Alaska, and birds encountered on the coast tend to be migrants rather than overwintering birds.
4. Blue-winged Teal are shot primarily in the local area in British

Columbia, and there does not seem to be any supplemental source of these birds outside the province.

5. Locally produced Shovelers are taken to a certain extent in British Columbia but the bulk of the harvest occurs in California. Some birds taken in the interior and on the coast are from Alberta and Alaska.
6. Locally produced Pintails are not generally available to local hunters but are harvested primarily in California. Those taken in British Columbia are from Alberta, Mackenzie and Yukon - harvested in the interior and the southwest; and from Alaska - harvested in the southwest and on the coast. Most birds found on the coast are winter residents.
7. Redheads are harvested locally and there is no supplementation by populations from outside British Columbia.
8. Locally produced Canvasbacks are harvested mostly south of British Columbia. Those taken in British Columbia have come primarily from Alaska.
9. Lesser Scaup are harvested more or less uniformly throughout the Pacific Flyway. Local kill is supplemented by birds from Alaska.
10. Locally produced Barrow's Goldeneye are subjected to a very heavy local harvest. All the birds found on the British Columbia coast seem to have come from the interior of the province, and there is no movement into British Columbia of birds banded elsewhere.
11. The harvest of Bufflehead produced in British Columbia is well dispersed throughout the Pacific Flyway. Additional birds are available on the coast and in the southwest from populations in Alberta and Alaska.
12. Recovery patterns of Canada Geese banded in British Columbia seem to indicate that there are some population differences throughout the southern part of the province. Birds from Vanderhoof, 100 Mile House and the Okanagen seem to fly southeast and south through the Okanagan valley.

13. Geese coming from Vanderhoof are not providing very much local harvest, while those from 100 Mile House and the Okanagan are.

14. Geese from the Chilcotin tend to fly onto the coast near the Lower Mainland. As a result they provide a considerable harvest near Vancouver.

15. The introduced geese at Vancouver and on northern Vancouver Island are providing almost exclusively for local harvest, and are essentially non-migratory.

16. Areas for which little or no information is available, such as the Kamloops area, the Kootenays, and all of the northern part of the province, warrant a banding effort soon. The mainland coast and the Queen Charlotte Islands should also be included. The continental decline in ducks and the general increase in geese (except coastal Alaskan geese) may result in more hunting pressure on British Columbia populations.

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Appendix I. Numbers of the major species of ducks banded in British Columbia between 1951 and 1984.

Year	Species and Location (I/C)[1]											
	MALL[2]		AMWI		GWTE		BLWT		SHOV		PINT	
	I	C	I	C	I	C	I	C	I	C	I	C
1951	101	42	153		51		49		10		26	
52	153	1	183		60		20				31	
53	2	1	23		16		15			1		
54	25		81				6		20		5	
55		2	42				1				5	
56	1	12				1				1		1
57	177	1	225		41		99		26		74	
58	259	65	303	3	116		657		54		99	
59	221	59	224	2	150		915		60		77	
1960												
61	6	90		119								
62	37				1							
63		29										
64	17		17		5		8					
65		58				37		2				5
66	25	1188[3]	3	2		2	6					
67	118	106	102		17		19		27	6	48	2
68	275		65		87		120				256	
69	460	17	14	164	34		9		2		40	
1970												
71	119	94	4		23		67	4	2	2	4	
72		492		18				19		10		13
73	158	147	7	10	6	34	11				7	10
74		58		2				1				3
75		471		414		9						200
76		776		465		12		1				13
77		414				2		1				135
78		17				2						
79	251		6		15	12	1			1	3	
1980		76		2				21				3
81		97		3								1
82												
83						14		7				
84	118		3		1						18	97
Total	2523	4313	14551	1204	629	125	2003	56	201	21	693	483

1 I = Interior; C = Coast

3 1149 were experimentally relocated

2 Species codes are:

MALL=Mallard
AMWI=Wigeon
GWTE=Green-winged Teal
BLWT=Blue-winged Teal
NOSH=Shoveler
NOPI=Pintail
REDH=Redhead
CANV=Canvasback
LESC=Lesser Scaup
BAGO=Barrow's Goldeneye
BUFF=Bufflehead

Appendix I. (continued)

Year	Species and Location (I/C)[1]									
	REDH		CANV		LESC		BAGE		BUFF	
	I	C	I	C	I	C	I	C	I	C
1951	109		16		714	2	1201		325	
52	119		36		602	1	1324		321	1
53	41		3		303		519		82	
54	21		3		233		259		54	
55	9				77		280		114	
56					1		46			
57	110		15		117		675		87	
58	124		37		307		942		211	
59	68		47		130		568		131	
1960					33		50		20	
61							3		15	
62									17	
63										
64									5	
65										
66										2
67	20		7		58		262		30	
68	133				4					
69	2									2
1970						96				
71	1				2	52	11			
72				1						
73	2									
74										
75						3				1
76						2				
77										
78										1
79						63	21		4	
1980										
81										
82							64		89	
83						1	58		130	
84						119	100		128	
Total	759		164	1	2575	339	6383		1763	7

Appendix II. Minor species of waterfowl banded in British Columbia between 1951 and 1984.

Because so few birds in this category have been banded and recovered plotting return distribution on maps was not warranted. Instead the information is presented in tabular form, showing the number and locations of banding (Table II-1) and recovery (Table II-2). Table II-3 summarizes the return rates in the two major banding areas, the interior and the coast, and Table II-4 shows recovery information by species.

Table II-1. Total numbers of the minor species of ducks banded in British Columbia from 1951 to 1984.

Species	Number Banded	Locations
Common Merganser	21	Big Qualicum River area
Red-breasted Merganser	1	Southern Vancouver Island
Hooded Merganser	2	Kamloops area
Cinnamon Teal	79	45% near Vancouver; Ft. St. John and Kamloops
Greater Scaup	33	All coastal, most in Ladner area
Ring-necked Duck	58	Most in Cariboo area
Common Goldeneye	24	70 Mile area and East Kootenays
Oldsquaw	3	Near Vancouver
Harlequin Duck	6	Near Victoria
White-winged Scoter	65	Most in the Cariboo area
Surf Scoter	1	Near Victoria
Ruddy Duck	104	Cariboo area
Total	397	

Table II-2. Number of recoveries of the minor species of ducks banded in British Columbia from 1951 to 1984, by banding location.

Species	Area[1] 1	2	3	4	5	6	7	8	9
Common Merganser	-	-	-	-	-	-	-	-	-
Red-breasted Merganser	-	-	-	-	-	-	-	-	-
Hooded Merganser	-	-	-	1	-	-	-	-	-
Cinnamon Teal	-	-	-	-	-	-	-	-	5
Greater Scaup	-	-	-	-	-	-	-	-	1
Ring-necked Duck	-	-	-	3	2	-	-	2	-
Common Goldeneye	-	-	-	2	-	-	-	1	-
Oldsquaw	-	-	-	-	-	-	-	-	-
Harlequin Duck	-	-	-	-	-	-	-	-	-
White-winged Scoter	-	-	-	1	-	-	-	4	-
Surf Scoter	-	-	-	-	-	-	-	-	-
Ruddy Duck	-	2	4	1	-	-	-	-	-
Total birds recovered	-	2	4	8	2	-	-	7	5

1 1 Ft. St. John
2 Williams Lake
3 70 Mile House
4 Kamloops
5 Okanagan
6 Creston
7 East Kootenays
8 Rest of the province
9 Coast

Table II-3. Band return rates for the minor species of ducks banded in the interior and on the coast of British Columbia between 1951 and 1984.

Species	Location and Return Rate					
	Interior			Coast		
	# banded	# returned	return rate (%)	# banded	# returned	return rate (%)
Common Merganser	-	-	-	21	0	0
Red-breasted Merganser	-	-	-	1	0	0
Hooded Merganser	2	1	50.0	-	-	-
Cinnamon Teal	22	0	0	57	5	8.8
Greater Scaup	-	-	-	33	1	3.0
Ring-necked Duck	58	7	12.1	-	-	-
Common Goldeneye	20	2	10.0	4	0	0
Oldsquaw	-	-	-	3	0	0
Harlequin Duck	-	-	-	6	0	0
White-winged Scoter	64	5	7.8	1	0	0
Surf Scoter	-	-	-	1	0	0
Ruddy Duck	104	7	6.7	-	-	-
Total	270	22	8.1	127	6	4.7

Table II-4. Banding and recovery information for the minor species of ducks banded in British Columbia between 1951 and 1984.

Species	Banding Information				
	banding date	banding location	recovery location	status	recovery type
Hooded Merganser	July 1959	505 1201	490 1192	300	direct
Cinnamon Teal	Aug 1968	491 1163	370 1205	300	direct
	Aug 1968	491 1163	364 1214	300	indirect
	Aug 1968	491 1163	370 1205	300	indirect
	July 1973	490 1230	430 1241	400	direct
	July 1973	490 1230	390 1220	400	indirect
Greater Scaup	April 1973	491 1230	491 1230	300	indirect
Ring-necked Duck	July 1951	514 1212	488 1208	300	indirect
	Aug 1951	501 1191	504 1103	300	direct
	Aug 1951	501 1191	501 1191	300	direct
	Aug 1952	500 1202	380 1221	300	direct
	Aug 1952	521 1215	435 1230	300	direct
	July 1954	515 1220	390 1225	300	indirect
	Aug 1967	515 1220	520 1220	300	direct
Common Goldeneye	Aug 1951	503 1201	502 1202	300	direct
	July 1971	503 1200	502 1200	300	direct
White-winged Scoter	Aug 1951	514 1211	513 1210	300	direct
	Aug 1952	514 1211	451 1235	300	direct
	Aug 1954	521 1215	411 1240	300	indirect
	Aug 1954	503 1205	503 1205	300	direct
	Aug 1958	521 1215	480 1230	300	direct
Ruddy Duck	July 1951	515 1220	421 1214	300	indirect
	Aug 1952	515 1220	520 1221	300	direct
	Aug 1952	520 1221	382 1221	300	unknown
	July 1953	515 1220	373 1221	300	indirect
	July 1953	515 1220	520 1220	300	indirect
	Aug 1955	520 1220	454 1233	300	indirect
	July 1959	505 1201	373 1221	300	indirect